Secretary of the Navy/Chief of Naval Operations
Chairs of Oceanographic Sciences

W.A. Kuperman
Marine Physical Laboratory
Scripps Institution of oceanography
La Jolla, CA 92093-0238
phone: (858) 534-7990 fax:(858) 534-7641 email: wak@mpl.ucsd.edu

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http://www-mpl.ucsd.edu

LONG-TERM GOALS

The central efforts are to conduct research in ocean acoustics and signal processing, educate graduate students and participate in the ONR research community.

OBJECTIVES

Conduct long-term basic research in ocean acoustics, with emphasis on involving graduate students, post docs and junior researchers in the research. Concerning graduate students, goals include both exploring research ideas that may lead to thesis research and the thesis research itself. Another important objective is to establish a scale model acoustic facility that can be used for research and training. A further objective is to periodically interact with ONR personnel on issues concerning their research community.

APPROACH

This grant has been supporting a post doc this year. Further, a scale model research facility, previously constructed on this grant, has been utilized and experiments related to shallow water propagation, high resolution focusing of fields in free space and a (shallow water) waveguide. Most recently, a study relating moving foci to Cerenkov radiation has been underway.

WORK COMPLETED

We have recently pulished the results of a study involving the use of signals that may contain some very low level residual component of its near field. The idea is to then “amplify that component that have minimal near field structure. That component is referred to as the evanescent field. The theory of the processing has been developed, simulations indicate that the process is viable and some initial air acoustics experiment confirm the technique. We have also been working on the theory of supersonic moving foci. We have shown that the field from a supersonic (or equivalently superluminal) point source in uniform motion (i.e. the Cherenkov-Vavilov effect) is equivalent to the diffractionless X-wave field (a wave type previously described by an ad hoc construction). In the context of the CV solution, it is clear that any superluminal properties exhibited by X-waves are purely phase effects. It is demonstrated that that the power required to support an X-wave is equivalent to the power dissipated by a CV source. In Fig. 1, we show that the CV “particle” is the causal part of the X-wave. The

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14. ABSTRACT
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15. SUBJECT TERMS

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specific parameters of the geometry are shown in Fig. 2 while the full field simulation with levels are given in Fig., 3.

Our most recent efforts have been applying the above work to the concept of creating a virtual source array. Preliminary simulations indicate that such a construct is feasible. We will be doing a laboratory experiment to confirm these ideas.

As a SecNav chair, I have had meetings with all levels of ONR managements on an assortment of ONR and research community issues.

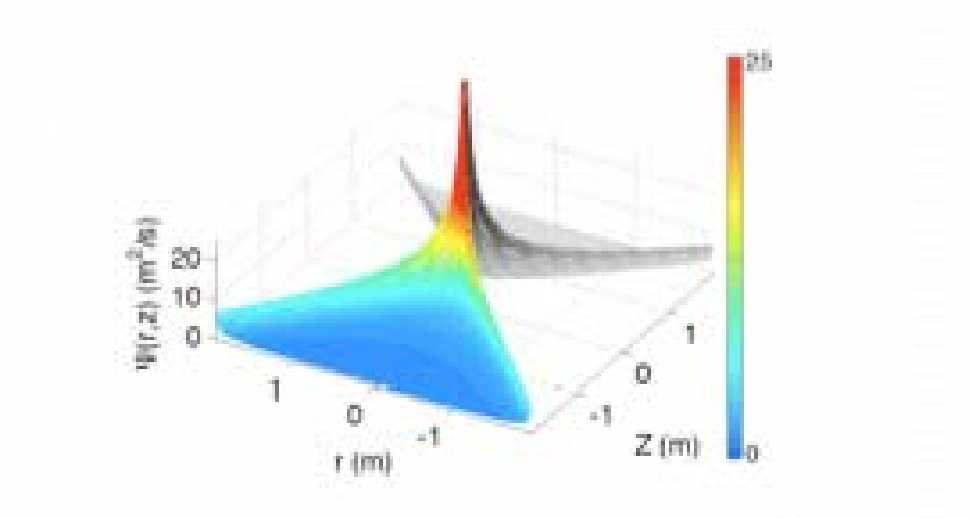

Fig. 1. Infinite bandwidth X-wave field. The field is taken at time t = 0. A supersonic/superluminal CV particle generates a field comprising expanding cylindrical waves (colored region) and constitutes the causally consistent portion of a radially-standing X-wave field (both colored and black and white region).

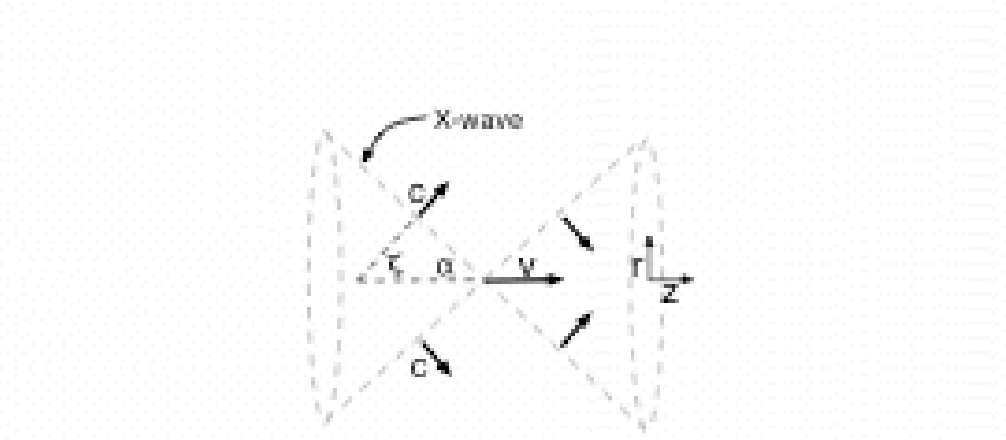

Fig. 2. Conical geometry of X-waves. The radially-standing X-wave, propagating at speed |v| > c, comprises both expanding and collapsing cylindrical waves. The surface of the cone defines a Mach cone of opening angle $\alpha = \arcsin(c/|v|) = |\pi/2 - \zeta|$

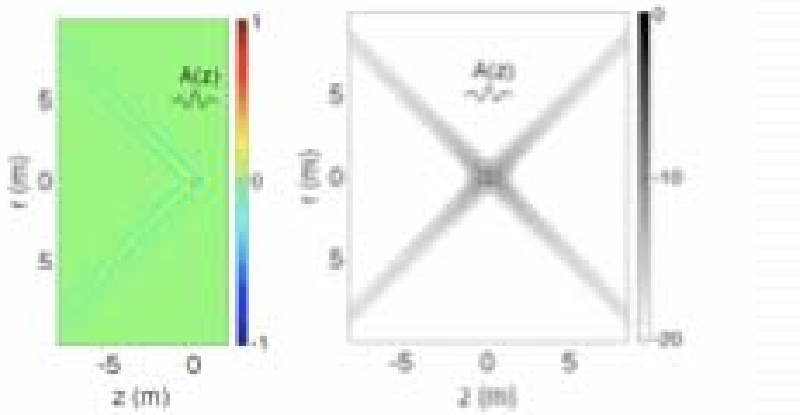

Fig. 3. Cross-section of simulated CV field and radially-standing X-wave field. (a) The CV cone generated by an axial monopole source distribution, A(z). (b) The Associated radially-standing X-wave field. Graphic (b) is plotted in dB to provide a wider fidelity range.

PUBLICATIONS

"The Cherenkov-Vavilov formulation of X-waves," S. C. Walker and W. A. Kuperman, submitted to PRL.